Activity Revision Collaboration (ARC)

Activity: The Quadratic River Application with Area and Perimeter

Course: College Algebra

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Instructional Plan:

Activity Abstract: In both parts of the College Algebra Quadratic River Application activity, students will work with applying a quadratic function to a scenario. In part one, students will initially access prior knowledge of area and perimeter of rectangles to engage with the material with tables and GeoGebra. Through the structure of the activity, students will then transition to making algebraic representations of area and perimeter given particular constraints of the scenario. Lastly, students will find the length and width that will maximize an area. In part two, students will complete a similar task to reinforce the idea that the vertex of the quadratic provides maximum area.

Rationale for selecting/designing this problem/task sequence:

This activity focuses on a river application of quadratics involving perimeter and area of rectangles. This scenario/idea is something that comes up with college algebra and calculus questions and ties together geometry with algebra through quadratic functions. In College Algebra, students are often asked to find the vertex and identify it as a maximum or minimum point; however, in this question, students must realize that the maximum area is found by identifying the vertex.

Prerequisite Knowledge:

- Students need to have knowledge of calculating the area and perimeter of rectangles.
- Students should be able to apply the distributive property.
- Students should have knowledge of solving linear equations.
- Students should know basic characteristics about quadratic functions including how to find the vertex of a quadratic function given in general form using $x = -\frac{b}{2a}$ and y = f($-\frac{b}{2a}$).

Learning objective(s) and alignment with Student Learning Outcomes (SLOs From CEP Matrix):

- Identify quantities and changes in quantities in mathematical representations, and distinguish constants from variables.
- Create models for real-world situations through appropriate mathematical strategies.
- Interpret functions and convert between their representations, including symbols, tables, graphs, and words.
- Perform operations on functions and identify the properties and characteristics of functions. Such properties and characteristics include domain and range, increasing and decreasing, one-to-one, inverses, even and odd, end behavior, relative extrema, and vertical and horizontal asymptotes.
- Identify and sketch graphs of functions including linear, polynomial, absolute value, rational, radical, piecewise functions, exponential, logarithmic, and use transformations of basic graphs.

MIP Components of Inquiry:

This section outlines how our activity will meet the Mathematical Inquiry Project (MIP) criteria for active learning, meaningful applications, and academic success skills.

Active Learning: Students engage in active learning when they work to resolve a problematic situation whose resolution requires them to select, perform, and evaluate actions whose structures are equivalent to the structures of the concepts to be learned.

- For this activity, we modified the problem to include a build-up to the idea of maximizing or minimizing the area of rectangles. We provided students a table with different lengths and widths; having them find areas of those specific rectangles. In providing tables, students are able to have flexibility in choice of selecting rectangular widths and lengths. The students explore what happens when they pick different values that have the same perimeter, but varied area.
- We found an online tool (Geogebra) with sliders for students to consider more options to help them generalize this idea of maximizing the area of the rectangle. This provides them an instant depiction of the area through the use of unit squares, again to help the students with this generalization. Students are able to select different lengths and widths, perform the action of finding the area of each rectangle, and evaluate what happens to the area based on the different lengths and widths.
- We removed the original picture so that students must visualize the rectangle on their own. They must realize only three sides are utilized (no fencing needed on the river side). They must determine how to represent each side algebraically.

Meaningful Applications: Applications are meaningfully incorporated in a mathematics class to the extent that they support students in identifying mathematical relationships, making and justifying claims, and generalizing across contexts to extract common mathematical structure.

- By creating the table as the starting point for this problem, students can start to make and justify claims in maximizing and minimizing areas for rectangles. This can be generalized to connect it to the original problem. Students can identify units for each part of the problem.
- The instructions help the student identify that the vertex of the parabola is the point where the maximum area occurs and have the students use $x =- \frac{b}{2a}$ to find the vertex (or lengths/widths) of the rectangle. Including a part two to this activity gives students an additional opportunity to make the connection with the vertex representing maximum area.
- Instructors can expand the problem by using different fence lengths or different perimeters (maybe given to different groups) in order to help with seeing patterns in what happens to maximize the area.

Academic Success Skills: Academic success skills foster students' construction of their identity as learners in ways that enable productive engagement in their education and the associated academic community.

- Students should have productive engagement by exploring different lengths and widths of rectangles. They will engage with the problem (through the context, table, and geogebra) and have productive struggle to determine how to find the maximum area of a rectangle.
- Students should build a bigger connection that the vertex of a quadratic graph is the maximum or minimum on the graph, but also in the maximum or minimum values in the context of real-life applications.
- This problem would seem to be student-friendly/accessible in setting up the original drawing and understanding the general context of the problem. This might reduce students' math anxiety and make them feel more empowered to approach the problem.